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LAS VEGAS METROPOLITAN AREA AIR POLLUTANT EMISSION INVENTORY

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A summary of the emission inventory is presented for the Las Vegas Metropolitan Area. The report provides estimates of the present levels of air pollutant emissions and the status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are delineated with respect to source type, season of the year, and geographical distribution within the area. The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of portions of four counties surrounding Las Vegas. A grid coordinate system was used to show the geographical distribution of emissions within counties. All sources of emissions were classified into five categories: transportation, stationary fuel combustion, solid-waste disposal, industrial processes, and evaporative losses.

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PUBLIC HEALTH SERVICE
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Division of Air Quality and Emission Data
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PREFACE

This report, which presents the emission inventory for the Las Vegas Metropolitan Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These surveys, conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the National Air Pollution Control Administration, provide estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.[1] These reports are intended to serve as aids in the proposing of boundaries of Air Quality Control Regions, as directed by the Air Quality Act of 1967.

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INTRODUCTION

This report is a summary of the Las Vegas air pollutant emission inventory conducted in March 1970. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1969 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of portions of four counties surrounding Las Vegas. This area covers approximately 19,400 square miles and had a 1969 population of 311,000.

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 76 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 1,600 square kilometers in the rural areas.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources, while the many remaining contributors such as motor vehicles, residential and commercial fuel users, small industries and on-site refuse burning equipment, were considered collectively as area sources. For this report, thirty individual sources, which had emissions greater than 50 tons per year for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a particular source category. Since individual sources have inherent

differences that cannot always be taken into consideration, descrepancies between the actual and estimated emissions are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, these estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions in the Study Area.

SUMMARY

The annual emissions as estimated by the Las Vegas Metropolitan Area Air Pollutant Emission Inventory are:

Sulfur Oxides	14,900
Particulates	63,500
Carbon Monoxide	209,100
Hydrocarbons	29,800
Nitrogen Oxides	22,800

The following is a brief description of the air pollutant emissions as presented in Table1 and Table 2.

Sulfur Oxides: The largest source of sulfur oxides in the Study Area was a coal burning power plant in Clark County. This plant accounted for over 80 percent of the total sulfur oxide emissions. The combustion of fuel oil at stationary sources was the second largest category contributing 11 percent of total emissions. The only other significant source was motor vehicles, which accounted for 6 percent of the total sulfur oxides.

Particulates: Individual point sources of particulates from industrial processes accounted for almost 84 percent of the total particulate emissions in the Las Vegas Study Area. Even though this area was void of any heavy industry, it did have a large number of plants in the mineral products industry. The largest sources in these industries were lime plants, gypsum plants, asphalt batching operations, ready-mix plants and miscellaneous sand and gravel operations. Collectively, these plants accounted for almost 83 percent of the 84 percent contributed by industrial process sources. The only other large source

of particulates was the coal burning power plant which accounted for 7 percent of total emissions.

Carbon Monoxide: In most metropolitan areas the largest source of carbon monoxide emissions is from automobiles and other motor vehicles. This was also true in Las Vegas as motor vehicl es contributed 93 percent of the carbon monoxide emitted annually. Other transportation sources including railroad and aircraft operations contributed another 4 percent.

The only other significant source of carbon monoxide was from the inefficient cambustion of refuse at open burning dumps and incinerators. This category accounted for about 3 percent of the total emissions.

Hydrocarbons: Evaporative losses from automobiles which includes losses from the gas tank, carburetor and engine crankcase accounted for 27 percent of total hydrocarbon emissions. Other smaller evaporative loss sources--gasoline storage and handling, industrial solvent usage, dry cleaning plants and miscellaneous solvent usage collectively accounted for 14 percent of the total hydrocarbon emissions.

Exhaust gases from motor vehicles was a primary source of hydrocarbon emissions, accounting for over 47 percent of the total. Other sources included the open burning of solid waste and railroad and aircraft operations, which accounted for 2 and 9 percent, respectively, of total emissions.

Nitrogen Oxides: The major source of nitrogen oxides was the exhaust gas from motor vehicles, which together with other transportation sources contributed over 50 percent of the total emissions.

The combustion of coal and natural gas at the steam-electric plants in the Study Area was a large source of nitrogen oxides. In the Las Vegas area this source category accounted for 34 percent of the total emissions.

The remaining 2 percent of the total nitrogen oxides came from the disposal of refuse by incineration and open burning.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN LAS VEGAS STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	900	1,740	196,400	15,100	9,700
Other	60	1,570	7,100	2,500	1,600
Subtotal	960	3,310	203,500	17,600	11,300
Stationary Fuel Combustion					
Industry	200	130	10	10	1,100
Steam-Electric	12,000	8,900	160	60	7,700
Residential	400	100	20	30	350
Commercial and Institutional	1,100	400	50	50	1,900
Subtotal	13,700	9,530	240	150	11,050
Refuse Disposal					
Incineration	200	960	4,200	80	290
Open Burning	10	220	1,200	420	150
Subtotal	210	1,180	5,400	500	440
Industrial Processes	--	49,500	--	--	--
Evaporative Losses	--	--	--	11,500	--
GRAND TOTAL[a]	14,900	63,500	209,100	29,800	22,800

a Totals have been rounded.

TABLE 1A SUMMARY OF AIR POLLUTANT EMISSIONS IN LAS VEGAS STUDY AREA, 1969 (10^3 kg/year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	816	1,578	178,174	13,698	8,799
Other	54	1,424	6,441	2,268	1,451
Subtotal	870	3,002	184,615	15,966	10,250
Stationary Fuel Combustion					
Industry	181	118	9	9	998
Steam-Electric	10,886	8,074	145	54	6,985
Residential	363	91	18	27	317
Commercial and Institutional	997	363	45	45	1,724
Subtotal	12,427	8,646	217	135	10,024
Refuse Disposal					
Incineration	181	871	3,810	72	263
Open Burning	9	200	1,088	381	136
Subtotal	190	1,071	4,898	453	399
Industrial Process	--	44,900	--	--	--
Evaporative Losses	--	--	--	10,430	--
GRAND TOTAL[a]	13,500	57,600	189,700	27,000	20,700

a Totals have been rounded.

TABLE 2 PERCENTAGE CONTRIBUTION OF EACH SOURCE CATEGORY TO TOTAL EMISSIONS IN THE LAS VEGAS STUDY AREA

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	6.1	3.0	92.6	47.2	42.6
Other	0.4	2.6	4.1	9.0	7.0
Subtotal	6.5	5.6	96.7	56.2	49.6
Stationary Fuel Combustion					
Industry	1.2	0.2	N	N	4.8
Steam-Electric	80.5	7.2	0.1	0.2	33.9
Residential	2.8	0.2	N	0.1	1.5
Commercial and Institutional	7.6	0.7	N	0.2	8.2
Subtotal	92.1	8.3	0.1	0.5	48.4
Refuse Disposal					
Incineration	1.3	1.6	2.5	0.3	1.3
Open Burning	0.1	0.4	0.7	1.5	0.7
Subtotal	1.4	2.0	3.2	1.8	2.0
Process Losses	--	84.1	--	--	--
Evaporative Losses	--	--	--	41.5	--
TOTAL	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF STUDY AREA

The Study Area for the emission survey of the Las Vegas Metropolitan Area consists of portions of four counties--all of Clark County, Nye County as far north as Bearry, Mohave County to its southern boundary and as far west as Kingman, and a narrow strip of San Bernadino County along the Colorado River. The four-county area is located in the southern tip of Nevada at the junction of the three states of Nevada, California and Arizona. Figure 1 shows the location of the Las Vegas Study Area relative to other large cities in its vicinity.

Figure 2 represents a more detailed drawing of the Las Vegas Study Area showing the major urban areas. It should be pointed out that the boundaries of these areas do not correspond to city limits, but rather give a general outline of the major clusters of population. The Study Area occupies approximately 19,000 square miles and contained an estimated 1969 population of 311,000. It should be noted that this does not include the great influx of tourists into Las Vegas which is estimated to add about 70,000 people on any given day.[3] The population density map (Figure 3) shows the heaviest concentrations near Las Vegas.

TOPOGRAPHY[4]

Las Vegas is situated near the center of a broad desert valley, which is almost completely surrounded by mountains ranging from 2,000 to 10,000 feet higher than the floor of the valley. To the north the valley is bounded by the Sheep range, the Spring Mountain range to the west, the McCullough range to the south, and the River Mountains and Sunrise Mountain to the east. This Vegas Valley, compromising about 600 square miles, runs from northwest to southeast, and slopes gradually upward on each side towards the surrounding mountains. In general these topographic conditions are a big factor in the air pollution problem in the Las Vegas area.

Figure 1. Map of Las Vegas Study Area and surrounding cities.

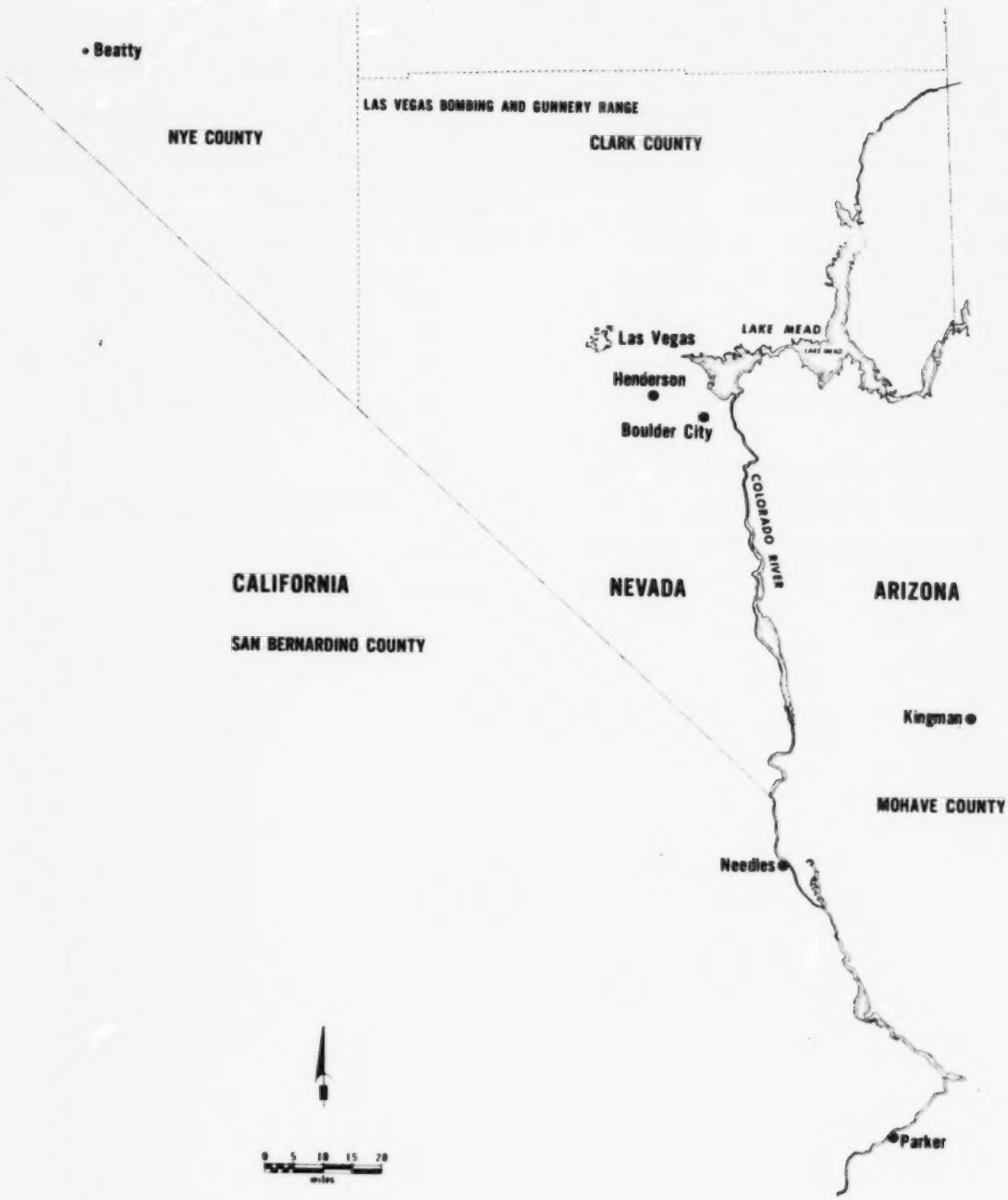

Figure 2. Detailed map of Las Vegas Study Area.

TABLE 3 AREA AND POPULATION CHARACTERISTICS FOR THE LAS VEGAS STUDY AREA

County	Land Area (Sq. Mi.)	Population 1960	Population 1969	Population Density (1969)
Clark	7,874	127,000	290,000[b]	37
Mohave[a]	4,500	c	17,100	4
Nye[a]	3,000	c	2,400	0.8
San Bernadino[a]	4,000	c	1,500	0.4
TOTAL	19,374	c	311,000	16

a - Includes only a portion of the entire county.

b - Does not include an average daily level of approximately 70,000 tourist

c - Estimate not available for 1960.

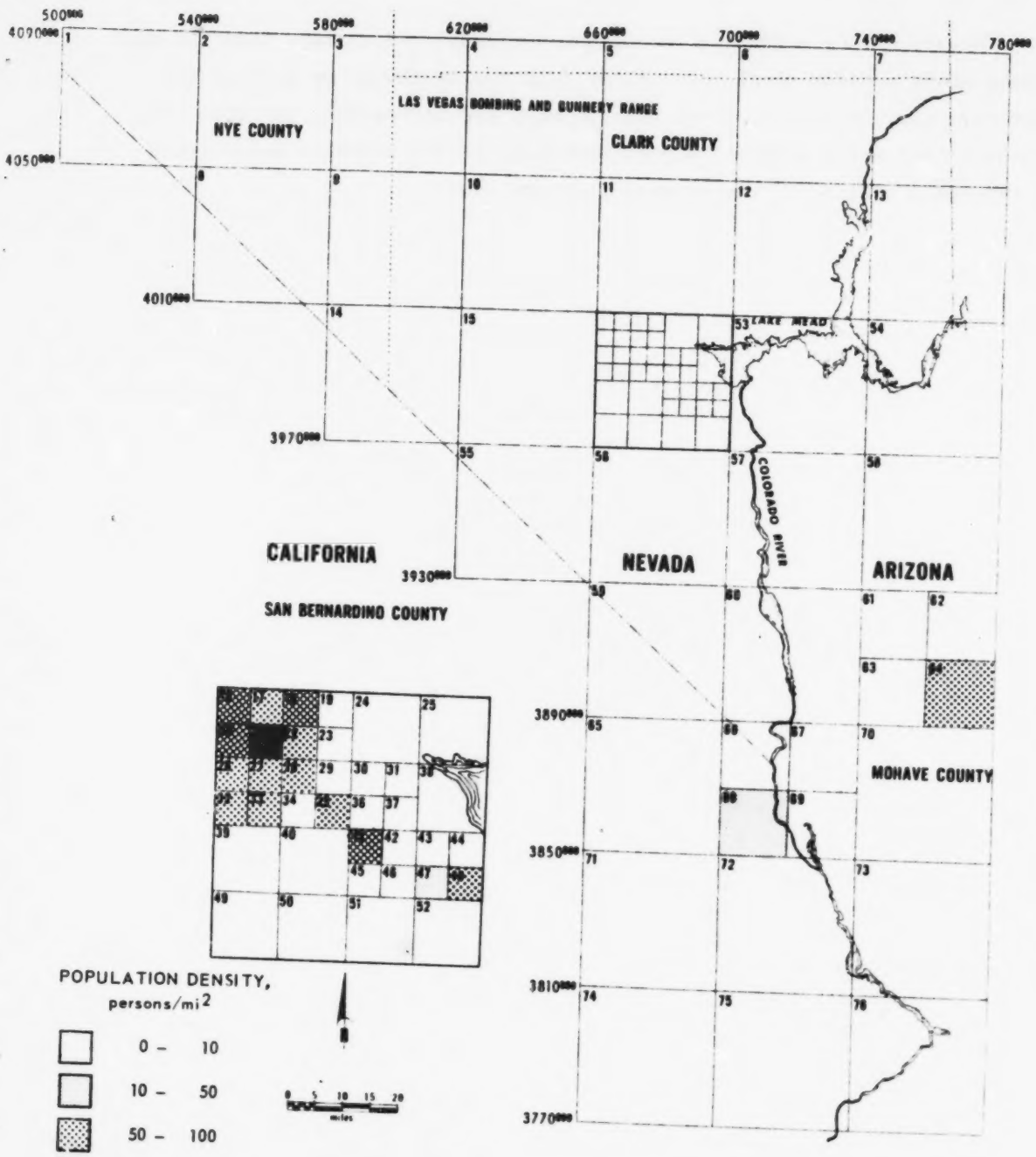

Figure 3. Population density map of Las Vegas Study Area.

CLIMATOLOGY

The prevailing winds are out of the southwest and average about 10 mph. Strong winds usually reach this valley from the southwest or through the pass from the northwest. Winds over 50 mph. are infrequent, but when they do occur they are probably the most provoking of the elements experienced in the area, because of the blowing dust and sand.

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM) was used in the Las Vegas Study Area to show the geographical distribution of emissions. A map of this grid system is presented in Figure 4.

The UTM system was chosen due to its advantages over other standard grid systems such as the Latitude-Longitude and State Plane Coordinate Systems. The major advantages of this system are that (1) it is continuous across the country and is not hindered by political subdivisions, (2) the grids are of uniform size throughout the country, (3) it has world-wide use, and (4) the grids are square in shape--a necessary feature for use in meteorological dispersion models.

The Universal Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid line, as illustrated in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid is identified by the horizontal and vertical coordinates of their geographical center to the nearest 100 meters.

As shown in Figure 4, the Study Area was divided into 76 grids of four different sizes--25, 100, 400 and 1,600 square kilometers. Grid zones of different sizes are used to limit the number of grid zones and yet allow a satisfactory definition of the geographical gradation of emissions. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas in order to reflect abrupt changes in emissions within short distances. The use of grid zones smaller than 25 square kilometers is not warranted because of the inherent inaccuracies in the data. Since only a small percentage of the total emissions occur in rural areas, larger grid zones are normally used to show the distribution of emissions in these lightly populated portions of a Study Area.

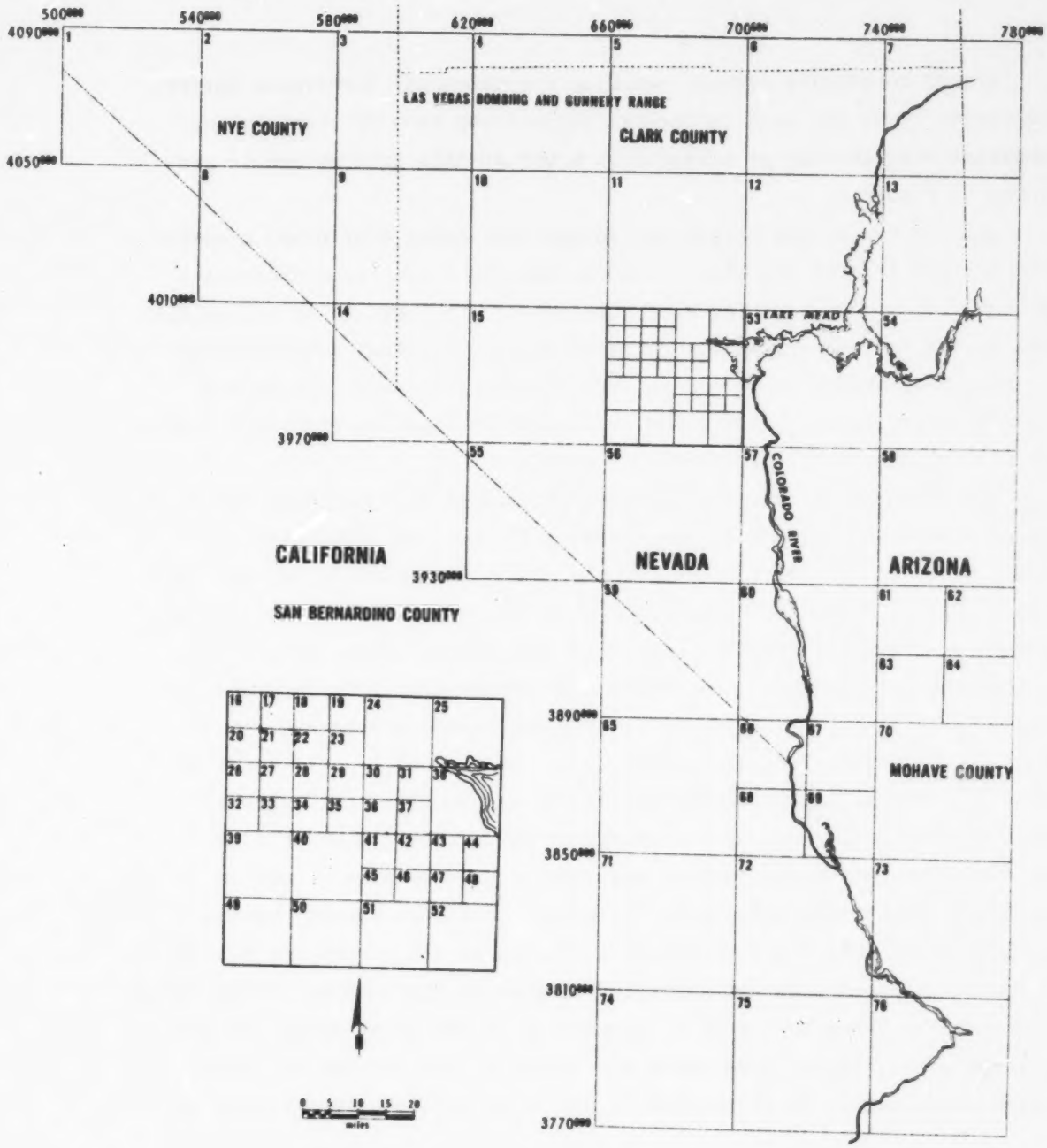

Figure 4. Grid coordinate system for Las Vegas Study Area.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following five categories:

1. Stationary fuel combustion
2. Transportation
3. Solid Waste disposal
4. Industrial processes
5. Evaporative losses

Each of these categories is considered individually in this section where data sources are given and methods of calculation discussed.

STATIONARY FUEL COMBUSTION

The stationary fuel combustion category is concerned with any fixed source which burns fuels for either space heating or process heating. The four primary sources in this category are industrial facilities, steam-electric plants, residential housing, and commercial and institutional establishments. In the Las Vegas area coal, natural gas, fuel oil, and liquified petroleum gas were the primary fuels used. Table 4 presents a summary of the fuels consumed in the Study Area.

Steam-Electric Utility

METHODOLOGY: Data on the four power plants in the area were acquired from each of the acknowledged air pollution agencies and compared to figures presented by the National Coal Association.[5] The data included the annual fuel consumption for 1968 and the method of firing employed at each plant.

RESULTS: Three of the four power plants in the area were gas fired and one was coal fired. These steam-electric generating plants consumed over 35 percent of the total natural gas utilized by all sources, and 100 percent of the coal. Air pollutant emissions from fuel combustion at

TABLE 4 ANNUAL FUEL CONSUMPTION IN THE POLITICAL SUBDIVISIONS OF THE LAS VEGAS STUDY AREA, 1969

Jurisdiction	Steam-Electric Utility	Industrial	Residential	Commercial and Institutional	Total
Natural Gas (Million Cu. Ft.)					
Clark	7,000	7,400	3,700	2,800	20,900
Mohave	1,200	200	300	180	1,880
Nye	--	--	--	--	--
San Bernadino	--	--	200	50	250
Total	8,200	7,600	4,200	3,030	23,030
Distillate Oil (1000 Gallons)					
Clark	--	7,900	16,600	45,900	70,400
Mohave	--	100	70	150	320
Nye	--	--	--	--	--
San Bernadino	--	--	--	--	--
Total	--	8,000	16,670	46,050	70,720
Residual Oil (1000 Gallons)					
Clark	--	50	--	1,200	1,250
Mohave	--	--	--	--	--
Nye	--	--	--	--	--
San Bernadino	--	--	--	--	--
Total	--	50	--	1,200	1,250
LPG (1000 Gallons)					
Clark	--	--	1,800	200	2,000
Mohave	--	--	--	--	--
Nye	--	--	20	--	20
San Bernadino	--	--	--	--	--
Total	--	--	1,820	200	2,020
Coal (Tons)					
Clark[a]	631,500	--	--	--	631,500
Total	631,500	--	--	--	631,500

a = Approximately 4.5 million tons of coal will be burned in proposed power plant.

these plants as well as from all other fuel combustion sources are summarized in Table 5. The steam-electric plants were significant sources of all pollutants. Over 87 percent of the total sulfur oxides from stationary fuel combustion, 85 percent of the particulates, 66 percent of the carbon monoxide, 40 percent of the hydrocarbons and 70 percent of the nitrogen oxides were attributed to these plants.

Industrial

METHODOLOGY: Natural gas numbers were obtained from each of the local suppliers who provided the breakdown by user category. Fuel oil consumption figures were provided by the air pollution agencies in each county. Specific data on the natural gas and fuel oil consumption by individual plants was obtained for the largest plants in the area, and these were considered as point sources. It was assumed that all remaining industrial fuel consumption was an area source and was apportionned onto grids based on industrial land use.

It should be noted that fuel combustion by industries includes both fuel used for space heating, and fuel used for process heating. A national average was used to separate process heating from space heating.

RESULTS: The emissions from the combustion of fuels by industrial sources were almost insignificant contributing less than 2 percent of the stationary fuel combustion emissions for any pollutant.

Residential

METHODOLOGY: Natural gas, distillate fuel oil, and LPG, for all practical purposes, were the only fuels used for residential home heating. There were homes heated by other fuels, but they represent a very small percentage of the total. Data on the amount of natural gas used for domestic heating was supplied by the local power companies and compared with the rapid survey technique of estimating the fuel used for residential heating.[6] LPG consumption data and distillate oil consumption were estimated by local officials and also compared to the rapid survey technique.

TABLE 5 AIR POLLUTANT EMISSIONS FROM THE COMBUSTION OF FUELS IN STATIONARY SOURCES IN THE STUDY AREA, 1969

(Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Coal					
Industrial	--	--	--	--	--
Steam-Electric	12,000	8,840	160	60	6,300
Residential	--	--	--	--	--
Commercial and Institutional	--	--	--	--	--
Subtotal	12,000	8,840	160	60	6,300
Fuel Oil					
Industrial	180	60	10	10	290
Steam-Electric	--	--	--	--	--
Residential	410	70	20	30	100
Commercial and Institutional	1,140	360	50	50	1,700
Subtotal	1,730	490	80	90	2,090
Gas					
Industrial	N	70	N	N	810
Steam-Electric	N	50	N	N	1,370
Residential	N	40	N	N	240
Commercial and Institutional	N	30	N	N	160
Subtotal	N	190	N	N	2,580
GRAND TOTAL[a]	13,700	9,500	240	150	11,000

N = Negligible

a = Totals have been rounded

RESULTS: Residential sources accounted for 20 percent of the total hydrocarbons from stationary fuel combustion, and less than 3 percent of the emissions for all other pollutants.

Commercial and Institutional

METHODOLOGY: Commercial and institutional establishments use primarily natural gas and distillate fuel oil. Data on the amount of natural gas used by these establishments were provided by the local power company.

RESULTS: Commercial and institutional sources accounted for 8 percent of the total sulfur oxides from stationary fuel combustion, 8 percent of the particulates, 40 percent of the hydrocarbons, 17 percent of the nitrogen oxides and less than 1 percent of the carbon monoxide.

TRANSPORTATION

Three types of transportation sources of air pollution are considered in this survey--motor vehicles, aircraft, and railroads. Motor vehicles, which are by far the most significant source in this category, are further subdivided according to type of fuel--gasoline or diesel.

Motor Vehicles

More than 5 million miles were traveled by motor vehicles in 1969 in the Las Vegas Study Area. In the process, 125 million gallons of gasoline and 18 million gallons of diesel fuel were consumed for highway purposes. Table 6 shows the miles of travel for gasoline and diesel vehicles for each county in the Study Area.

Vehicle-mile data for essentially all of the roads in Clark County were supplied by the Clark County Health Department who had conducted an extensive survey for 1969. For Clark County, this data was in the form of traffic flow maps which showed vehicle mile data on a traffic zone basis. This data was then transferred onto the UTM grid zones and reported as total vehicle miles for each grid. In the remaining counties, vehicle-mile information was not available, and thus gasoline consumption was used to find vehicular emissions.[7]

TABLE 6 VEHICLE MILES OF TRAVEL FOR MOTOR VEHICLES IN THE LAS VEGAS STUDY AREA, 1969 (Thousand Vehicle Miles per Day)

Political Jurisdiction	Diesel Vehicle Miles	Gasoline Vehicle Miles	Total
Clark	230	4,370	4,600
Mohave	14	266	280
Nye	6	109	115
San Bernadino	11	209	220
TOTAL	261	4,954	5,215

The contribution to the total motor vehicle pollution by diesel-powered vehicles was determined by assuming that approximately five percent of the total vehicle miles traveled were by diesel-powered vehicles. This was checked by estimating diesel fuel consumption in each county.[8] These emissions were apportionned on a grid basis by assuming they were proportional to gasoline emissions.

Emissions from motor vehicles are a function of the speed at which the vehicle travels. Average speeds of 10-20 mph wer assumed for downtown areas, 20-30 mph for the residential areas, and 30-45 mph for the rural areas to calculate vehicle emissions.

From all transportation sources, motor vehicles accounted for 65 percent of the sulfur oxides, 44 percent of the particulates, 95 percent of the carbon monoxide, 82 percent of the hydrocarbons, and 79 percent of the nitrogen oxides. Gasoline powered motor vehicles contributed a greater percent of all pollutants than diesel powered motor vehicles. Emissions from transportation sources are summarized in Table 7.

Aircraft

Table 8 shows the air traffic activity at the largest airports in the Study Area. An estimate of the number of flights by engine type was supplied by the traffic controller at each airport and summarized in Table 8.

The air pollutant emissions from aircraft include all phases of operation (taxi, take-off, climb out, approach and landing) that take place below the arbitrarily chosen altitude of 3,500 feet. Emissions at cruise altitude (above 3,500 feet) are not of concern in an emission inventory. From all transportation sources, aircraft accounted for 40 percent of the particulates, 4 percent of the carbon monoxide, 14 percent of the hydrocarbons and 11 percent of the nitrogen oxides.

Railroads

Railroad operations (mainly locomotive) consume about 3 million gallons of diesel fuel per year within the Study Area. This quantity is about 80 percent less than the amount of diesel fuel consumed by motor vehicles. The majority of this fuel is consumed during switching operations. Diesel fuel consumption data were supplied by each of the major railroads in the Las Vegas area.

TABLE 7 SUMMARY OF EMISSIONS FROM TRANSPORTATION SOURCES, 1969

(Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxide
Motor Vehicles					
Gasoline	540	720	195,800	13,850	7,650
Diesel	370	1,020	560	1,260	2,060
Subtotal	910	1,740	196,360	15,110	9,710
Aircraft					
Jet	N	1,340	1,480	1,250	980
Piston	N	20	5,460	1,020	260
Turboprop	N	40	90	30	60
Subtotal	N	1,400	7,030	2,300	1,300
Railroads	60	170	90	210	340
GRAND TOTAL[a]	970	3,300	203,500	17,600	11,300

N = Negligible

a = Totals have been rounded

TABLE 8 AIR TRAFFIC ACTIVITY AT THE LARGEST AIRPORTS IN THE LAS VEGAS STUDY AREA, 1969 (Flights/Year)[a]

Type Aircraft	McCarron	Nellis AFB	North Las Vegas
2 Engine Conventional Jet	42,000	9,200	5,700
3 Engine Conventional Jet	--	19,600	--
4 Engine Conventional Jet	--	20,000	--
3 Engine Fan Jet	58,000	--	--
4 Engine Fan Jet	28,000	--	--
1 Engine Turboprop	3,400	10,000	3,600
2 Engine Turboprop	7,300	22,000	7,300
4 Engine Turboprop	3,700	5,800	--
1 Engine Piston	15,000	--	10,300
2 Engine Piston	12,100	1,100	7,700
4 Engine Piston	--	5,200	--
TOTAL	169,500	92,900	34,600

a - Flight is defined as a combination of a landing and a take-off.

Railroad operations contribute about 5 percent of the particulates and 14 percent of the hydrocarbons from all transportation sources. They account for less than 3 percent of the emissions for any other pollutant.

SOLID WASTE DISPOSAL

Approximately 767,000 tons of refuse was generated during 1969 within the Study Area. Table 9 presents a solid waste balance for the Las Vegas Study Area, showing the various methods of disposal and the quantities disposed of by each method. The bulk of the refuse in Clark County was disposed of by landfills or non-burning dumps, whereas in all other counties it was burned in open burning dumps. Refuse data for all of the counties were supplied by the air pollution agencies in each county.

INDUSTRIAL PROCESSES

The Study Area is notably void of any heavy industrial complexes with the exception of the Henderson industrial complex. From an air pollution standpoint, the mineral products industry was by far the most significant industrial process source. The largest sources in this industry were three lime manufacturing plants, two gypsum plants, seven asphalt batching operations, two cinderblock plants, five ready-mix plants and three miscellaneous sand and grevel operations plants. Other industries that generate air pollutant emissions from their processes include 1 potash plant and 1 titanium metals plant. Table 11 presents a summary of the emissions from the various industrial processes.

The three lime plants were the largest particulate sources from industrial processes. Approximately 1.8 million tons of dolomatic lime were mined and processed in 1969. Operations at these plants which release contaminants include mining, crushing and pulverizing, screening and the emissions from the lime kilns. All of the kilns at these plants are equipped with multicyclone mechanical dust collectors to control emissions.

TABLE 9 SOLID WASTE BALANCE FOR LAS VEGAS STUDY AREA, 1969

Jurisdiction	Total Refuse Generated	On-site Incineration	Landfills Non-Burning Dumps	Open Burning Dumps	Open Burning On-site
Clark	735,000	188,400	546,600	--	--
Mohave	22,000	2,200	--	20,000	NA
Nye	3,000	300	1,000	1,700	NA
San Bernadino	7,000	700	--	6,300	NA
TOTAL	767,000	191,600	547,700	28,000	--

NA = Information not available or not reported

TABLE 10 AIR POLLUTANT EMISSIONS FROM SOLID-WASTE DISPOSAL IN LAS VEGAS STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Incineration					
Municipal	--	--	--	--	--
On-Site	190	960	4,200	80	290
Subtotal	190	960	4,200	80	290
Open Burning					
On-Site	NA	NA	NA	NA	NA
Dump	10	220	1,200	420	150
Subtotal	10	220	1,200	420	150
GRAND TOTAL	200	1,180	5,400	500	440

TABLE 11 AIR POLLUTANT EMISSIONS FROM INDUSTRIAL PROCESSES, 1969
(Tons/Year)

Source Category	Particulates
Chemical Process Industry	
Potash	40
Metallurgical Industry	
Titanium	600
Mineral Products Industry	
Lime	29,300
Gypsum	6,400
Asphalt	6,600
Cinder Block	Neg.
Ready Mix	3,800
Sand and Gravel Operations	2,800
Subtotal	48,900
GRAND TOTAL	49,540

These plants accounted for almost 60 percent of the total particulates from industrial processes. However, it must be taken into consideration that over 70 percent of these emissions are particles bigger than 20 microns and thus settle out within short distances.

Approximately 700,000 tons of gypsum are mined at the two sites in the Study Area. The pulverizing, crushing, screening and stockpiling operations that take place at these plants contribute 13 percent of the total process particulates.

At the seven asphalt plants the actual batching operation along with sand and gravel mining accounted for 13 percent of the total process particulates. Mining operations associated with ready mix production and other sand and gravel operations collectively account for 13 percent of the total particulate emissions from industrial processes.

The only other significant industrial process source of particulates was the one titanium plant. Miscellaneous operations including magnesium chloride recovery, reduction, crushing and leaching accounted for only a small percentage of total process emissions.

EVAPORATIVE LOSSES

Three source categories were considered for evaporative losses--automobiles, gasoline storage and handling, and the consumption of solvents. The hydorcarbon emissions from all sources by evaporative losses are shown in Table 12.

Automobiles

Automobile evaporation losses include gas tank and carburetor evaporation and engine crankcase blowby. Since 1963, most new automobiles were equipped with positive crankcase ventilation (PCV) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that 20 percent of the automobiles were not equipped with PCV valves.

The hydrocarbon emissions from automobiles were calculated from vehicle-mile data and were apportioned onto grids using the same methods as for motor vehicles discussed earlier. Evaporative losses from automobiles accounted for 66 percent of the total hydrocarbon emissions from evaporative losses in the Study Area.

Gasoline Storage and Handling

There are four major points (excluding evaporation from the motor vehicle) of hydrocarbon emissions in the storage and handling of gasoline. They are:

1. Breathing and filling losses from storage tanks
2. Filling losses from loading tank conveyances
3. Filling losses from loading underground storage tanks at service stations
4. Spillage and filling losses in filling automobile gas tanks at service stations.

Approximately 135 million gallons of gasoline and diesel fuel were consumed in the Study Area in 1969. The evaporative losses from the storage and the subsequent handling of the gasoline accounted for 19 percent of the total evaporative losses.

Consumption of Solvents

This category included the consumption of solvents at dry cleaning plants, industrial solvent usage and the miscellaneous use of solvents by small commercial establishments and domestic units. Organic solvents emitted from these operations were determined by assuming an emission rate of 4 lb/capita/year for dry cleaning plants, and 3 lb/capita/year for miscellaneous consumption.[9,10] The industrial solvent consumption was based on actual numbers provided by the local agencies. The consumption of solvents by these three categories accounted for 15 percent of the hydrocarbon emissions from evaporative losses.

TABLE 12 HYDROCARBON EMISSIONS FROM EVAPORATIVE LOSSES, 1969

(Tons/Year)

Source Category	Hydrocarbon Emissions
Automobiles	7,600
Gasoline Storage and Handling	2,000
Consumption of Solvents	
Dry Cleaning Plants	760
Industry	690
Miscellaneous	470
Subtotal	1,920
GRAND TOTAL	11,520

EMISSIONS BY JURISDICTION

The previous section presented the air pollutant emissions by source category. In order to show the contribution of each county to the pollution in the entire Study Area, their emissions are summarized in Tables 13 through 16.

As is expected due to a higher degree of urbanization than the other counties, Clark County accounts for 99 percent of the total sulfur oxides in the Study Area, 93 percent of the particulates, 91 percent of the carbon monoxide, 90 percent of the hydrocarbons, and 92 percent of the nitrogen oxides.

TABLE 13 SUMMARY OF AIR POLLUTANT EMISSIONS IN CLARK COUNTY, 1969
(Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	800	1,540	180,700	13,800	8,600
Other	20	1,460	7,060	2,380	1,420
Subtotal	820	3,000	187,760	16,180	10,020
Stationary Fuel Combustion					
Industry	180	120	10	10	970
Steam-Electric	12,000	8,900	160	60	7,700
Residential	410	100	20	30	320
Commercial and Institutional	1,140	380	50	50	1,860
Subtotal	13,730	9,500	240	150	10,850
Refuse Disposal					
Incineration	190	940	4,140	80	280
Open Burning	--	--	--	--	--
Subtotal	190	940	4,140	80	280
Industrial Processes	--	46,440	--	--	--
Evaporative Losses	--	--	--	10,220	--
GRAND TOTAL[a]	14,700	59,900	192,100	26,600	21,200

N = Negligible

a = Totals have been rounded

TABLE 14 SUMMARY OF AIR POLLUTANT EMISSIONS IN MOHAVE COUNTY, 1969
(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	50	90	8,900	720	520
Other	40	110	60	140	220
Subtotal	90	200	8,960	860	740
Stationary Fuel Combustion					
Industry	N	10	N	N	130
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	20
Commercial and Institutional	N	10	N	N	160
Refuse Disposal					
Incineration	N	10	50	N	N
Open Burning	10	160	850	300	110
Subtotal	10	170	900	300	110
Industrial Processes	N	3,060	N	N	N
Evaporative Losses	--	--	--	660	--
GRAND TOTAL[a]	100	3,400	9,900	1,800	1,800

N = Negligible

a = Totals have been rounded.

TABLE 15 SUMMARY OF AIR POLLUTANT EMISSIONS IN NYE COUNTY, 1969

(Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	20	40	2,660	240	210
Other	--	--	--	--	--
Subtotal	20	40	2,660	240	210
Stationary Fuel Combustion					
Industry	N	N	N	N	N
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	N
Commercial and Institutional	N	N	N	N	N
Subtotal	N	N	N	N	[illegible]
Refuse Disposal					
Incineration	N	N	10	N	--
Open Burning	N	10	70	30	10
Subtotal	N	10	80	30	10
Industrial Processes	--	--	--	--	--
Evaporative Losses	--	--	--	210	--
GRAND TOTAL[a]	20	50	2,700	500	200

N = Negligible

a = Totals have been rounded

TABLE 16 SUMMARY OF AIR POLLUTANT EMISSIONS IN SAN BERNADINO COUNTY 1969, (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	30	70	4,130	380	380
Other	N	N	N	10	10
Subtotal	30	70	4,130	390	390
Stationary Fuel Combustion					
Industry	N	N	N	N	N
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	10
Commercial and Institutional	N	N	N	N	N
Subtotal	N	N	N	N	10
Refuse Disposal					
Incineration	N	N	10	N	N
Open Burning	N	50	270	90	30
Subtotal	N	50	280	90	30
Industrial Process	--	--	--	--	--
Evaporative Losses	--	--	--	390	--
GRAND TOTAL[a]	30	120	4,400	900	400

N = Negligible

a = Totals have been rounded.

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups--point and area sources. Thirty point sources are identified individually with respect to location and emissions. Each of these point sources emitted more than 50 tons per year of any pollutant.

CONTRIBUTIONS OF POINT AND AREA SOURCES

Figure 5 shows the location of all point sources in the area. Collectively the thirty point sources account for 80 percent of the sulfur oxides, 94 percent of particulate matter, 43 percent of nitrogen oxides, 4 percent of the carbon monoxide and 8 percent of the hydrocarbons. The percentage contribution to carbon monoxide emissions is low because motor vehilces, which are area sources, contribute 93 percent of the total carbon monoxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are the major sources. Table 17 presents the emissions of point sources. Each source is identified by source category, grid number and horizontal and vertical coordinates. The emissions of sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are shown for an average annual day, average winter day (December, January, February), and average summer day (June, July, August). The appendix presents the method of calculating these three averages.

Area sources are sources of emissions that are insignificant by themselves, but as a group may emit a large portion of the areas total pollution. Examples of area sources are motor vehicles, residences, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions from all sources by grid, as shown in Table 18. The emissions from all sources are also shown for an annual average, winter and summer day.

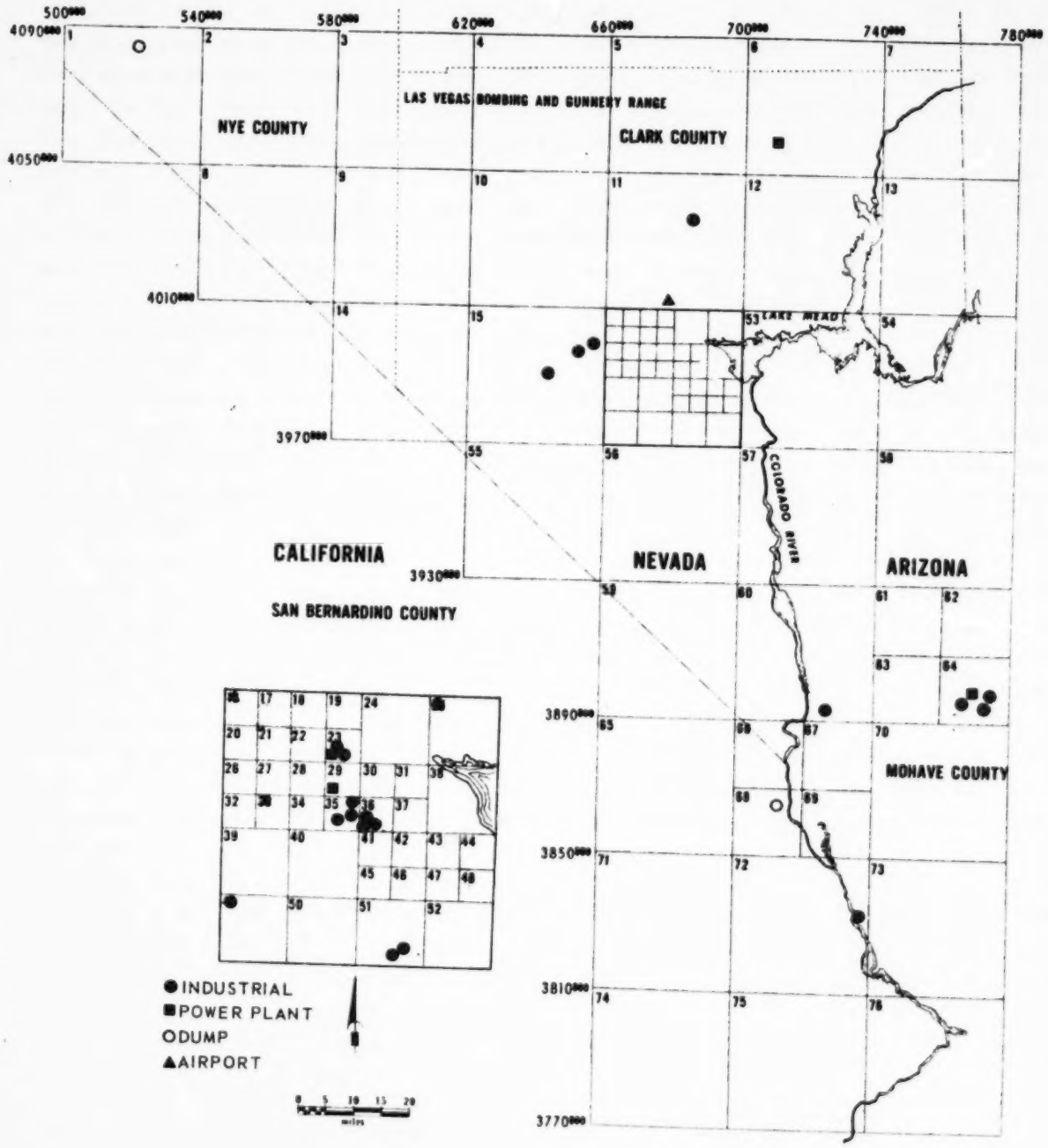

Figure 5. Location of point sources in Las Vegas Study Area.

TABLE 17 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES IN THE LAS VEGAS STUDY AREA
TONS/DAY

ID	GRIDHC	VC	SOX S	SOX W	SOX A	PART S	PART W	PART A	CO S	CO W	CO A	HC S	HC W	HC A	NOX S	NOX W	NOX A
5	1 5200	40850	0.0	0.0	0.0	0.02	0.02	0.02	0.15	0.13	0.13	0.04	0.04	0.04	0.01	0.01	0.01
4	6 7110	40595	46.6	33.3	32.8	34.38	24.55	24.22	0.61	0.43	0.43	0.24	0.17	0.17	24.55	17.54	17.30
2	11 6850	40360	0.0	0.0	0.0	31.99	31.99	31.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	11 6765	40118	0.0	0.0	0.0	1.91	1.91	1.91	6.47	6.47	6.47	1.35	1.35	1.35	1.45	1.45	1.45
2	15 6457	39914	0.0	0.0	0.0	10.89	10.89	10.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	15 6577	39992	0.0	0.0	0.0	13.59	13.59	13.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	15 6588	39993	0.0	0.0	0.0	3.76	3.76	3.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	16 6620	40090	0.0	0.0	0.0	0.16	0.16	0.16	4.02	4.02	4.02	0.77	0.77	0.77	0.28	0.28	0.28
2	23 6768	40031	0.0	0.0	0.0	0.66	0.66	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	23 6779	400 9	0.0	0.0	0.0	0.73	0.73	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	23 6769	400 9	0.0	0.0	0.0	0.12	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	3.15	2.25	2.22
2	25 6910	40090	0.0	0.0	0.0	6.50	6.51	6.51	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.34	0.25
4	29 6758	39952	0.0	0.0	0.0	0.08	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	2.17	1.55	1.52
7	33 6670	39940	0.0	0.0	0.0	1.75	1.75	1.75	8.76	8.76	8.76	4.19	4.19	4.19	1.83	1.83	1.83
2	35 6773	39919	0.0	0.0	0.0	1.16	1.16	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	35 6787	39922	0.0	0.0	0.0	1.20	1.20	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	35 6787	39942	0.0	0.0	0.0	4.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	36 6810	399 1	0.0	0.0	0.0	0.19	0.21	0.20	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.30	1.11
2	36 6820	399 1	0.0	0.0	0.0	1.67	1.68	1.68	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.58	0.50
2	36 6801	399 4	0.0	0.0	0.0	14.49	14.49	14.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	49 6610	39796	0.0	0.0	0.0	33.89	33.89	33.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	51 6864	39725	0.0	0.0	0.0	1.80	1.80	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	51 6863	39724	0.0	0.0	0.0	0.69	0.69	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	60 7220	38930	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7705	38977	0.0	0.0	0.0	0.64	0.64	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7670	38979	0.0	0.0	0.0	1.36	1.36	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7720	38995	0.0	0.0	0.0	5.79	5.79	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	64 7685	38973	0.0	0.0	0.0	0.00	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.35
5	68 7130	38660	0.0	0.0	0.0	0.12	0.12	0.12	0.64	0.64	0.64	0.22	0.22	0.22	0.08	0.08	0.08
2	72 7380	38910	0.0	0.0	0.0	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ID KEY

5 = Dump
4 = Steam-Electric Utility
2 = Industrial
7 = Airport

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TABLE 18 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES IN LAS VEGAS STUDY AREA, 1968
TONS/ DAY

GRID	(Sq. Mi.) AREA	SOX S	SOX W	SOX A	PART S	PART W	PART A	CO S	CO W	CO A	HC S	HC W	HC A	NOX S	NOX W	NOX A
1	617.7	0.0	0.0	0.0	0.1	0.1	0.1	3.2	2.5	2.9	0.6	0.5	0.5	0.3	0.2	0.3
2	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.4	1.6	0.3	0.2	0.3	0.2	0.1	0.1
3	617.7	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.6	1.9	0.3	0.3	0.3	0.2	0.1	0.1
4	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	617.7	46.7	33.5	32.9	34.4	24.6	24.3	2.5	1.9	2.1	0.6	0.4	0.5	24.7	17.8	17.5
7	617.7	0.0	0.0	0.0	0.1	0.1	0.1	3.9	3.0	3.5	0.6	0.5	0.5	0.2	0.2	0.2
8	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
9	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.2	0.2	0.2	0.1	0.1	0.1
10	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.6	0.2	0.2	0.2	0.1	0.1	0.1
11	617.7	0.0	0.2	0.1	34.0	34.1	34.0	12.9	11.5	12.3	2.3	2.1	2.2	1.9	2.1	1.9
12	617.7	0.0	0.1	0.0	0.0	0.0	0.0	2.4	1.9	2.2	0.3	0.3	0.3	0.2	0.2	0.2
13	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
14	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.9	0.2	0.1	0.2	0.1	0.1	0.1
15	617.7	0.1	0.1	0.1	28.4	28.3	28.4	7.7	6.0	7.0	1.0	0.8	0.9	0.5	0.4	0.5
16	9.6	0.2	0.5	0.3	0.8	0.8	0.8	32.6	26.4	30.1	5.3	4.6	5.0	1.9	1.8	1.8
17	9.6	0.3	0.5	0.4	0.5	0.5	0.5	56.6	43.8	51.5	6.2	4.9	5.7	2.6	2.4	2.5
18	9.6	0.4	0.4	0.4	0.7	0.6	0.7	68.0	52.6	61.9	8.5	6.6	7.7	3.7	2.9	3.4
19	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.2	2.4	2.9	0.4	0.3	0.3	0.2	0.1	0.2
20	9.6	0.2	0.5	0.3	0.6	0.6	0.6	41.7	32.5	38.0	5.4	4.4	5.0	1.9	1.7	1.8
21	9.6	1.0	7.6	3.4	2.0	4.0	2.8	147.4	115.2	134.5	17.3	14.6	16.2	5.4	14.4	8.7
22	9.6	0.1	0.2	0.1	0.3	0.2	0.3	22.0	17.0	20.0	2.9	2.3	2.6	1.2	1.0	1.1
23	9.6	0.0	0.0	0.0	1.5	1.5	1.5	0.3	0.2	0.2	0.0	0.0	0.0	3.2	2.3	2.2
24	38.6	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.1	2.5	0.4	0.3	0.3	0.2	0.1	0.2
25	38.6	0.0	0.0	0.0	6.5	6.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.3

TABLE 18 (cont.)

GRID	(Sq. Mi.) AREA	SOx S	SOx W	SOx A	S	W	A	CO S	CO W	CO A	HC S	HC W	HC A	NOx S	NOx W	NOx A
26	9.6	0.2	0.5	0.3	0.5	0.5	0.5	40.8	31.6	37.1	5.1	4.0	4.7	2.2	2.2	2.2
27	9.6	0.1	0.1	0.1	0.2	0.2	0.2	11.8	9.2	10.7	1.6	1.3	1.5	0.6	0.5	0.6
28	9.6	0.1	0.1	0.1	0.2	0.2	0.2	13.5	10.5	12.3	1.8	1.5	1.7	0.7	0.6	0.7
29	9.6	0.0	0.0	0.0	0.1	0.1	0.1	2.3	1.8	2.1	0.3	0.2	0.3	2.3	1.6	1.6
30	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	9.6	0.1	0.4	0.2	0.2	0.3	0.2	11.0	8.6	10.0	1.6	1.3	1.5	0.7	1.1	0.8
33	9.6	0.1	0.4	0.2	1.9	2.0	1.9	16.6	14.9	15.9	5.3	5.1	5.3	2.3	2.7	2.4
34	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.8	2.9	3.4	0.5	0.4	0.4	0.2	0.2	0.2
35	9.6	0.0	0.1	0.0	6.5	6.5	6.5	2.1	1.7	2.0	0.4	0.4	0.4	0.1	0.1	0.1
36	9.6	0.0	0.0	0.0	16.4	16.4	16.4	0.3	0.2	0.3	0.0	0.0	0.0	1.5	1.9	1.6
37	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
38	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	38.6	0.3	0.2	0.2	0.5	0.4	0.5	42.9	33.2	39.0	5.7	4.4	5.2	2.8	2.1	2.5
40	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.2	1.4	0.2	0.2	0.2	0.1	0.1	0.1
41	9.6	0.1	1.7	0.7	0.3	0.8	0.5	3.5	3.1	3.3	1.3	1.3	1.3	0.3	2.7	1.2
42	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
47	9.6	0.0	0.2	0.1	0.0	0.1	0.1	0.3	0.2	0.3	0.1	0.2	0.2	0.0	0.4	0.2
48	9.6	0.0	0.1	0.1	0.1	0.1	0.1	1.7	1.4	1.6	0.4	0.3	0.3	0.1	0.2	0.1
49	38.6	0.1	0.1	0.1	34.0	34.0	34.0	11.0	8.5	10.0	1.5	1.1	1.3	0.7	0.5	0.6
50	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	38.6	0.0	0.0	0.0	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.0	1.2	0.2	0.2	0.2	0.1	0.1	0.1
54	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.4	0.1	0.1	0.1	0.0	0.0	0.0

TABLE 18 (cont.)

GRID	(Sq. Mi.) AREA	SOx S	SOx W	SOx A	PART. S	PART. W	PART. A	CO S	CO W	CO A	HC S	HC W	HC A	NOx S	NOx W	NOx A
55	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
56	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.0	0.1	0.0	0.0	0.0
57	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.4	0.1	0.1	0.1	0.0	0.0	0.0
58	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
59	617.7	0.0	0.0	0.0	0.0	0.0	0.0	3.1	2.4	2.8	0.4	0.3	0.4	0.2	0.2	0.2
60	617.7	0.0	0.0	0.0	0.5	0.5	0.5	2.3	1.8	2.1	0.4	0.3	0.4	0.2	0.1	0.2
61	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.1	0.1	0.1	0.1	0.1	0.1
62	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
63	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.1	0.1	0.1	0.1	0.0	0.1
64	154.4	0.2	0.2	0.2	8.5	8.5	8.5	22.3	17.7	20.5	3.7	3.1	3.5	1.6	2.4	1.9
65	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.2	1.4	0.3	0.2	0.3	0.2	0.1	0.2
66	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
68	154.4	0.1	0.0	0.0	0.2	0.2	0.2	5.8	4.7	5.4	1.3	1.1	1.2	0.5	0.5	0.5
69	154.4	0.0	0.0	0.0	0.1	0.1	0.1	0.7	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2
70	617.7	0.0	0.0	0.0	0.1	0.1	0.1	0.7	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2
71	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	617.7	0.0	0.0	0.0	0.2	0.2	0.2	2.9	2.3	2.6	0.5	0.4	0.5	0.3	0.2	0.3
73	617.7	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1
74	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	617.7	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.1	2.5	0.5	0.4	0.4	0.3	0.2	0.2
76	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.5	0.1	0.1	0.1	0.1	0.0	0.0

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EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grids, emission density maps have been prepared. Emission densities were obtained by summing the annual area and point source emissions for each grid and dividing this total by the land area of the grid. Figures 6 through 10 show the variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities for carbon monoxide and hydrocarbons are higher in the grids with the higher populations and corresponding higher vehicular activity. Particulate emissions are high only in areas where industries are located and in grid 6 where the coal burning power plant is located. Sulfur oxide emission densities are relatively low in the Las Vegas area. The only grid with a high density was grid 6. This was due to the power plant located in this grid.

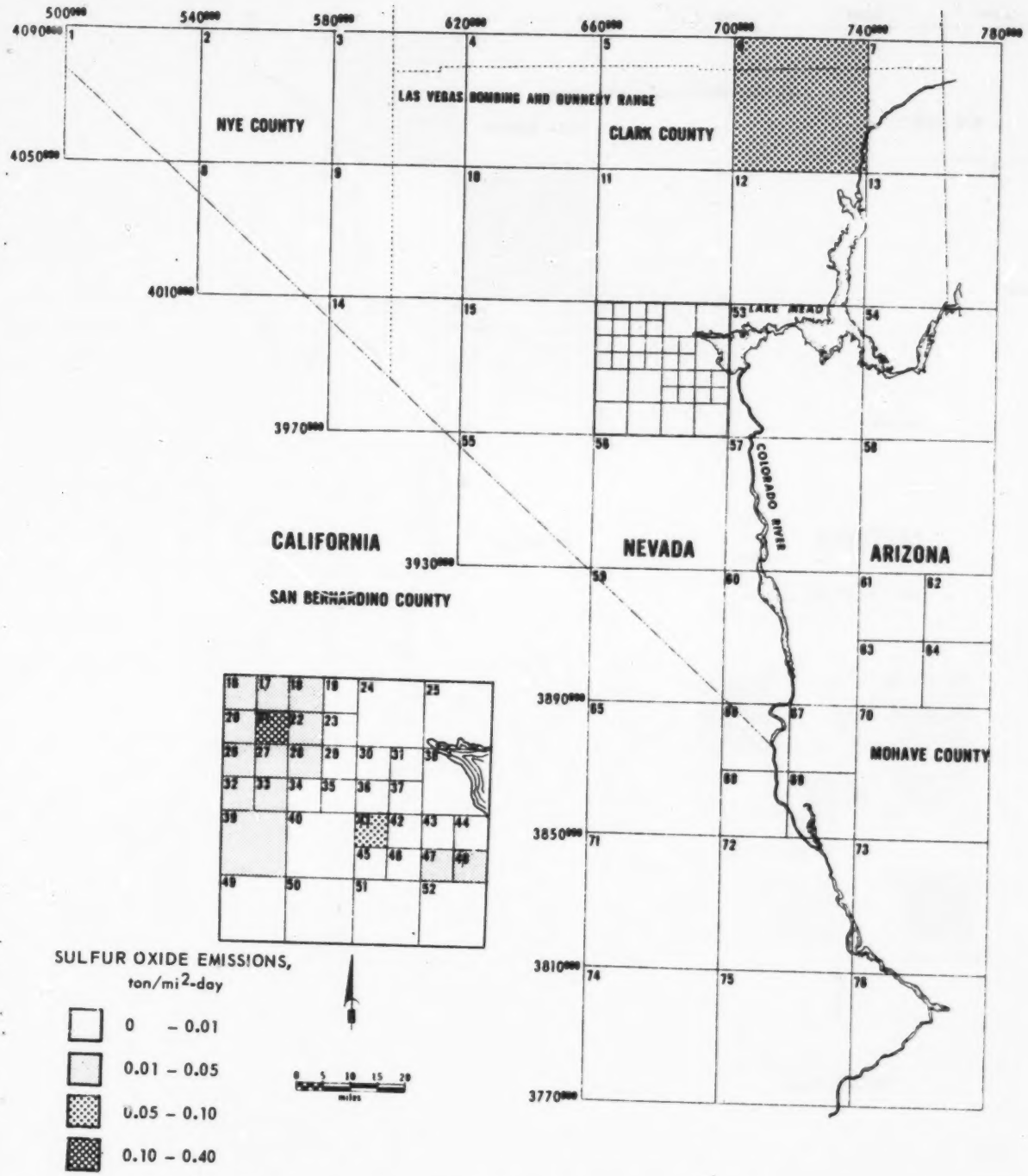

Figure 6. Sulfur oxide emission density from all sources in Las Vegas Study Area.

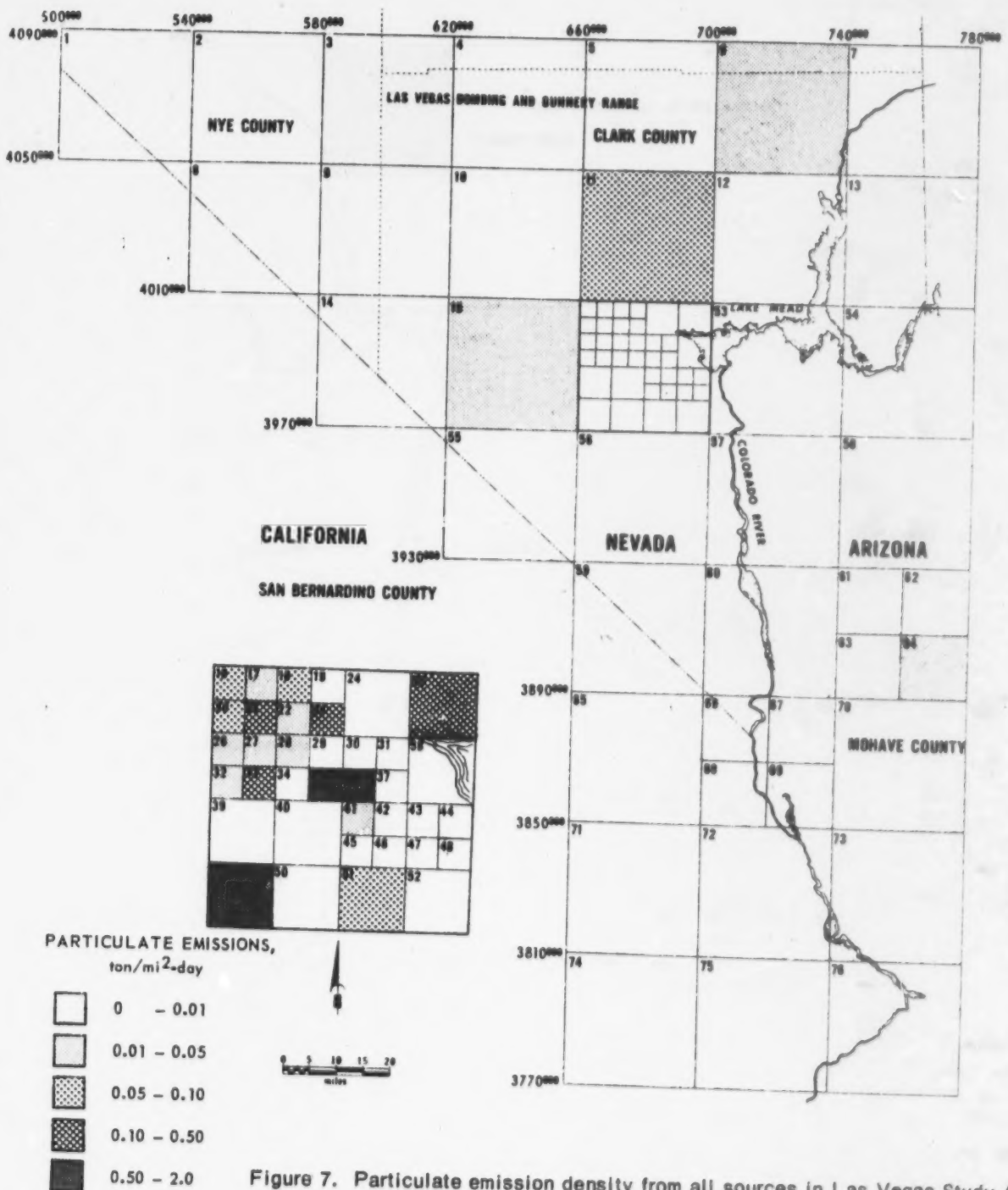

Figure 7. Particulate emission density from all sources in Las Vegas Study Area.

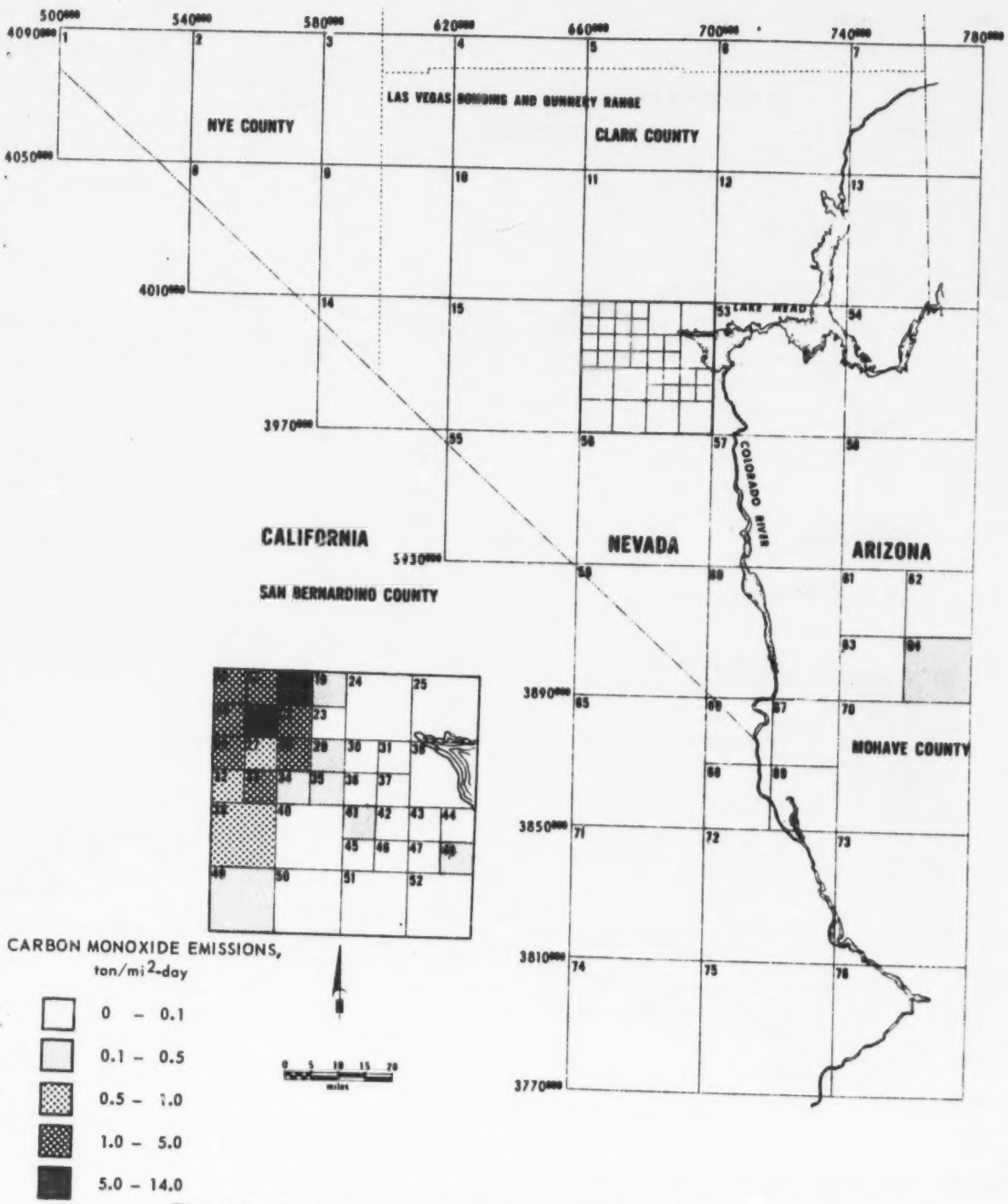

Figure 8. Carbon monoxide emission density from all sources in Las Vegas Study Area.

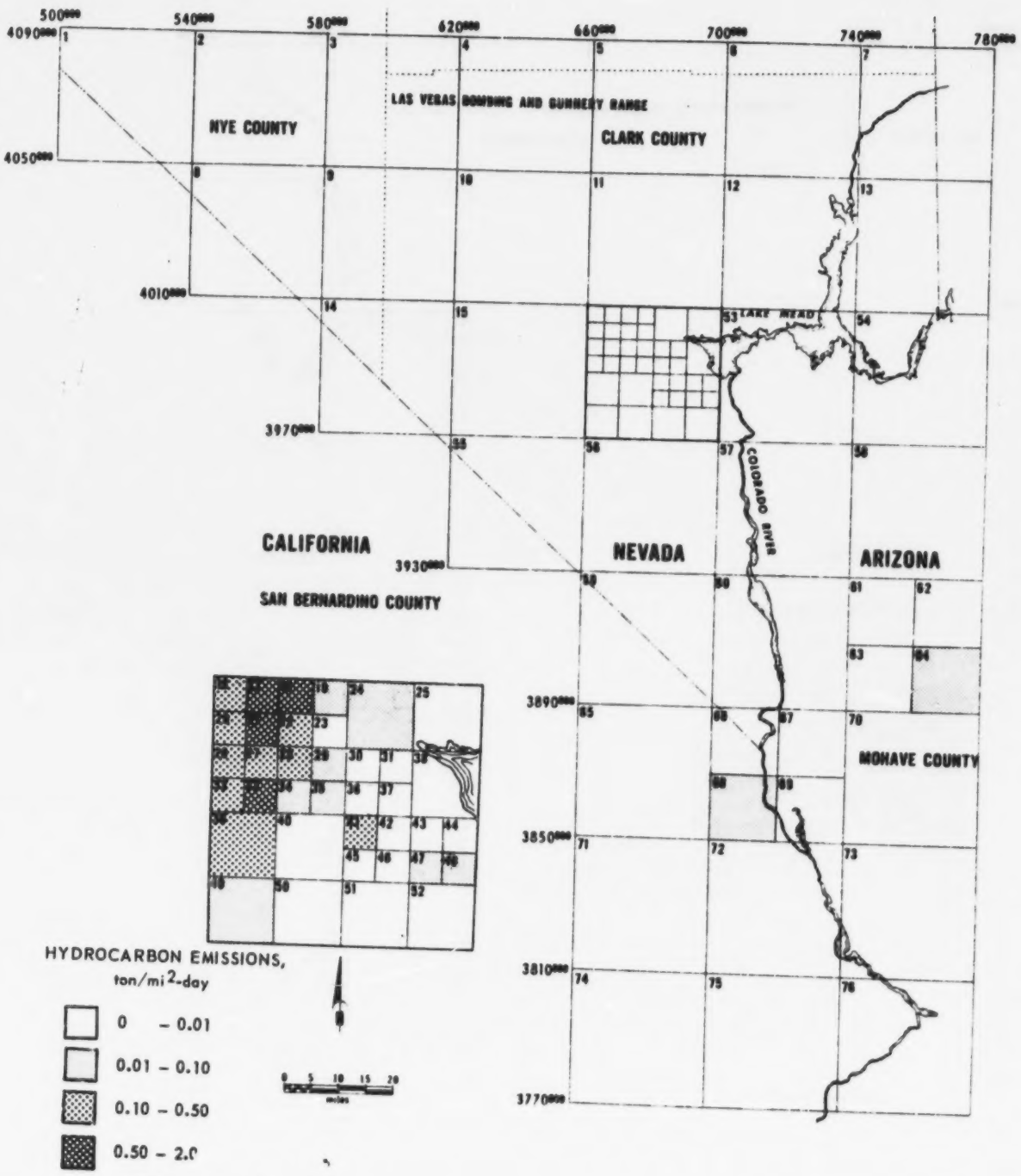

Figure 9. Hydrocarbon emission density from all sources in Las Vegas Study Area.

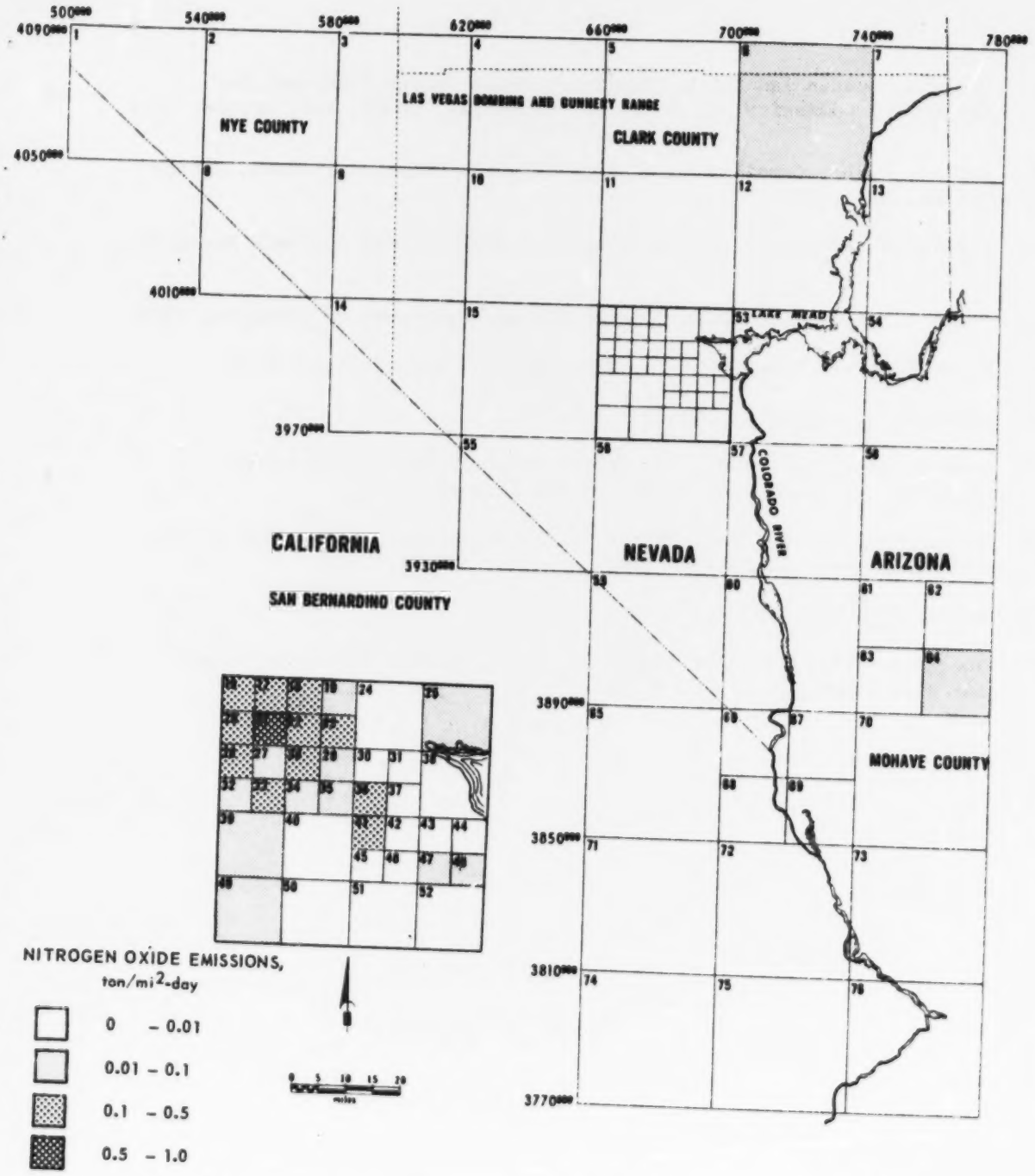

Figure 10. Nitrogen oxide emission density from all sources in Las Vegas Study Area.

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APPENDIX

METHOD FOR CALCULATING SUMMER, WINTER AND ANNUAL AVERAGE EMISSIONS FOR FUEL CONSUMPTION IN STATIONARY SOURCES

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100{,}000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2{,}000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$W = \left[\frac{100{,}000 \times 2{,}800}{90 \times 4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$S = \left[\frac{100{,}000}{90} \times \frac{0}{4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$S = 0.35 \text{ Ton/Day}$$

APPENDIX B
METRIC CONVERSION FACTORS

Multiply	By	To Obtain
Feet	0.3048	Meters
Miles	1609	Meters
Square Feet	0.0929	Square meters
Square Miles	2.59	Square kilometers
Pounds	453.6	Grams
Pounds	$453.6/10^4$	Tons (metric)
Tons (metric)	1.103	Tons (short)
Tons (short)	907.2	Kilograms
Tons (short)	.9072	Tons (metric)

To Obtain	By	Divide